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Graphene -Conducting Polymer Hybrids in Photovoltaic Applications

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Here we shall discuss mainly the replacement of TIO_2 active layer of dye sensitized solar cell (DSSC) with graphene conducting polymer hybrid. Both graphene oxide and graphene quantum dots are used for this purpose. The replacement of TiO_2 layer of the traditional DSSC is made by a newly synthesized semiconducting poly[3-(2-hydroxyethyl)-2,5-thienylene] grafted reduced graphene oxide (PHET-g-rGO) affording a reasonable PCE [1]. The TEM study indicates that in PHET-g-rGO the fibrous network morphology of PHET remains appended on the graphene surface making it a good electron transport promoter. The diffuse reflectance spectra correspond to a decrease of band gap from 1.86 eV in PHET to 1.38 eV in PHET-g-rGO. The photoluminescence (PL) intensity for pure PHET gets quenched and the emission peak gets red shifted by 13 nm due to grafting with rGO suggesting an efficient electron-hole pair separation. By first time replacing the TiO_2 in traditional DSSC with PHET-g-rGO the cell characteristics are as follows: the open circuit voltage equal to 0.61V, photocurrent density = 7.5 mA/cm^2 and the fill factor (FF) = 0.668 giving an overall power conversion efficiency(PCE) = 3.06 %. In order to improve the PCE further, aniline is in-situ polymerized in aqueous dispersions of graphene quantum dots GQDs to produce different polyaniline PANI-GQD (PAGD) hybrids. We have synthesized (GQDs) by a facile Sono-Fenton method and PAGD hybrids are produced without using any external dopant.[2] The fluorescence intensity of GQDs drastically quenches in the PAGD hybrids suggesting effective charge transfer between the GQDs and PANI chains. In PAGD composites the dc- conductivity increases by three orders from that of GQDs and the current-voltage (I-V) characteristics of PAGD composites indicate that on irradiation with light almost a reversible photoresponse occurs. DSSCs fabricated with PAGD hybrids and N719 dye indicate highest PCE of 3.12%. Impedance data of the PAGD hybrids exhibit semicircular The impedance spectra of the DSSCs indicate the presence of three semicircles exhibiting a complex equivalent circuit comprising of three R-C circuits and analysis of the data yield the life time values of photo-injected electrons supporting the PCE variation of PAGD hybrids. Trihybrid (GPPS) hydrogels constructed by 5,5'-(1,3,5,7-tetraoxopyrrolo[3,4-f]isoindole-2,6-diyl) diisophthalic acid (**P**), graphene oxide(GO) and PEDOT:PSS, are used for active layer of DSSCs[3]. DSSCs are fabricated taking the GPPS gels as active materials and PCE increases with increase of PEDOT:PSS concentration showing a maximum PCE of 4.5%. IPCE curve shows absorption range 360-700 nm with maximum absorbance of ~57%. The properties of methyl ammonium lead iodide($MAPbI_3$) perovskite solar cell with poly(3-thiophence acetic acid)(P3TAA) as hole transporting material(HTM) and dense layer of ZnO nanoparticles film as electron transporting material(ETM) is described using the conventional ZnO(n)/Perovskite(i)/P3TAA(p) (n-i-p) architecture[4]. The current density(J)–voltage(V) curves on illumination with light of 100 mW/cm^2 indicate the average PCE to be 7.38±0.59% at ambient condition. The UV-Vis and impedance spectral results clearly explain the above results, signifying the influence of interface on the performance of hybrid solar cells.

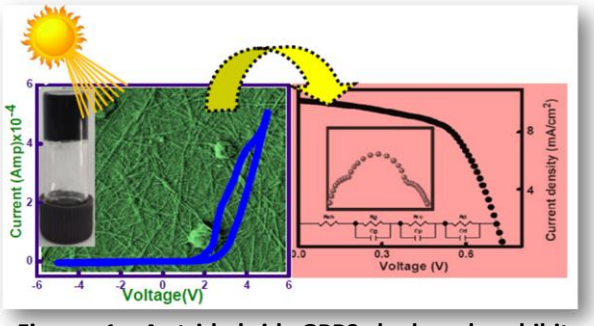

Figure 1. A tri-hybrid GPPS hydrogel exhibits excellent rectification property and acts as active material for DSSCs showing efficiency 4.5%.

References

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